§50. Physical Analyses of Magnetic Measurements in Large Helical Device

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For an experimental study on MHD equilibrium in helical devices, measurements of magnetic field and flux due to local currents which arise to satisfy ideal MHD equilibrium condition $\boldsymbol{J} \times \boldsymbol{B} = \nabla P$ are main subjects. In particular, the poloidal magnetic field and flux due to Pfirsch-Schlüter currents along magnetic field line causes the outward shift of magnetic axis, and this shift decides equilibrium β-limit and affects MHD characteristics. Also, there is some possibility that it destroys the peripheral magnetic surfaces. The magnetic measurements are valid to monitor the above-mentioned MHD characteristics, while they may give us information on pressure profile, current profile, beta value and so on.

The measurement systems for magnetic flux and magnetic field are being developed in LHD. The Rogowski coils, one-turn loops, diamagnetic loops, magnetic probes, hall probes and saddle loops are planned to be installed as basic systems.[1] To optimize the specification of the measurement systems, peripheral magnetic structure in finite-β plasmas with various parameters has been investigated using the 3-D magnetic field analysis code[2], which calculates the response from finite-β-equilibria constructed by the 3-D equilibrium code.[3] The dependence of pressure and current profile on magnetic loop and probe signals has been investigated. This analysis is also applicable to preparation for the database which is used for controlling magnetic configuration.

Figure 1 shows an example of poloidal array of magnetic probes. Three-type magnetic probes are installed to measure poloidal, radial and toroidal component of magnetic field, B_θ, B_r and B_ϕ, respectively. Figure 2 shows profiles of B_θ and B_r probe signals when the $<\beta>$ is 3 %. The horizontal axis means a distance from point A in Fig.1, and black and white arrows point to locations of B_θ and B_r probes, respectively. In practice, the measurement of parallel and perpendicular components, $\delta B_{\parallel}$ and $\delta B_{\perp}$, to inside wall of vacuum vessel is easier than that of poloidal and radial component, and therefore these components are analyzed here. The dipole structure is gradually formed by increasing P.S. currents as a function of $<\beta>$, although the profiles are distorted because these components are decided by the complex shape of vacuum vessel. The outward shift of peak of the profile in α=3 (peaked) case is larger than that in α=1 (broaden) case. This is reasonable for the dependence of pressure gradient on Shafranov shift.

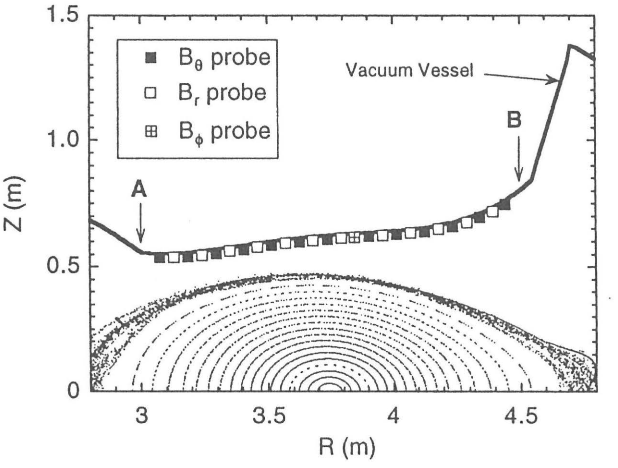

Fig.1 Location of poloidal array of magnetic probes.

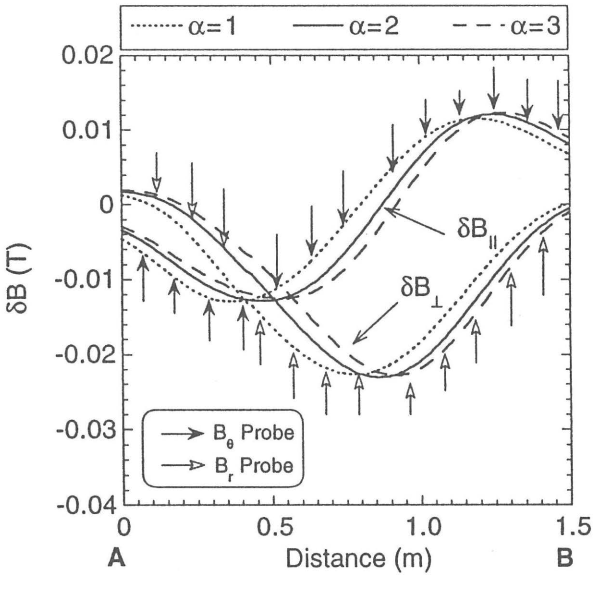

Fig.2 Profiles of probe signals when $<\beta>$ is 3%.

Reference

1) S. Sakakibara et al., Proc. International Conf. on Plasma Phys. vol.2 (1996) 1430.
2) H.J. Gardner, Nucl. Fusion 30 (1990) 1417.
3) S. P. Hirshman and W. I. van Rij: Comput. Phys. Commun. 43 (1986) 143.